IN THE UNITED STATES PATENT & TRADEMARK OFFICE

Applicant(s):	Robert J. Svoboda et al.	Examiner: S. Ahmed
Serial No.:	10/797,301	Art Unit: 1792
Filed:	March 9, 2004	Confirmation No. 4465
For:	CERAMIC ASSEMBLY WITH A STABILIZER LAYER	

ROBERT J. SVOBODA – DECLARATION UNDER 37 C.F.R. § 1.131

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

I, Robert J. Svodoba, declare that:

1. I was employed as a contract employee with Delphi Technologies, Inc. ("Delphi"), Troy, Michigan, during the relevant time period.

2. I graduated with a B.S. degree in chemical engineering from Michigan State University.

3. I am one of the inventors identified in the above-identified U.S. Patent Application Serial No. 10/797,301, filed on March 9, 2004, for a Ceramic Assembly With A Stabilizer Layer.

4. On or before August 1, 2002, Joseph M. Keller, another co-inventor in above-identified U.S. Patent Application Serial No. 10/797,301, and I conceived a method of producing a ceramic assembly, comprising: disposing an electrode precursor on an electrolyte precursor having an electrolyte sintering shrinkage; disposing a stabilizer precursor having a stabilizer sintering shrinkage on the electrode precursor on a side opposite the electrolyte precursor to form a precursor assembly, wherein a difference between the electrolyte sintering shrinkage and the stabilizer sintering shrinkage is less than or equal to ±1%; and sintering the precursor assembly to form the ceramic assembly comprising a stabilizer layer, electrode, and electrolyte, wherein a surface of the ceramic assembly has less than or equal to about 5.0 degrees camber, as measured from the horizontal plane. *See U.S. Patent Application No. 10/797,301*, claim 1.

5. On or before August 1, 2002, Joseph M. Keller and I conceived a method of producing a solid oxide fuel cell, comprising: disposing a first electrode precursor on a solid electrolyte precursor having an electrolyte sintering shrinkage; disposing a stabilizer precursor having a stabilizer sintering shrinkage on the first electrode precursor on a side opposite the electrolyte precursor to form a precursor assembly, wherein a difference between the electrolyte sintering shrinkage and the stabilizer sintering shrinkage is less than or equal to ±5%; disposing a second electrode precursor on a side of the solid electrolyte precursor opposite the first electrode precursor; and sintering the precursor assembly to form the ceramic assembly comprising a stabilizer layer, first electrode, and electrolyte, wherein a surface of the ceramic assembly has less than or equal to about 5.0 degrees camber, as measured from the horizontal plane. *See U.S. Patent Application No. 10/797,301*, claim 26.

6. Attached hereto is a true copy of relevant portions of a record of invention that was prepared in the United States of America prior to August 1, 2002 describing a method of adding a stabilizing layer to a solid-oxide fuel cell to increase the flatness of the solid oxide fuel cell, which was signed by Haskell Simpkins, Joseph M. Keller and me prior to August 1, 2002. *See Exhibit A (redacted)*, 7 pages.

7. The record of invention referred to in Paragraph 6 includes a description of a method of producing a ceramic assembly or solid oxide fuel cell including the steps of providing a electrolyte-anode precursor composite bi-layer, and disposing a stabilizing precursor layer on an anode side of the electrolyte-anode precursor composite bi-layer, wherein the stabilizing precursor layer has similar shrinkage properties as the electrolyte precursor to counter-balance the distortion caused by the shrinkage mismatch of the electrolyte and the anode that occurs during a sintering operation. *See Exhibit A (redacted)*, pgs. 1-3.

8. The record of invention referred to in Paragraph 6 shows that the method includes disposing a cathode precursor on a side of the electrolyte precursor opposite of the anode precursor. *See Exhibit A (redacted)*, pg. 3.

9. The record of invention referred to in Paragraph 6 discloses an illustration of the ceramic assembly or solid oxide fuel cell that is formed using the method described in Paragraphs 7 and 8, which includes a stabilizing layer, an anode, an electrolyte, and a cathode. *See Exhibit A (redacted)*, pg. 3.

10. Attached hereto as Exhibit B is a true and original copy of a presentation entitled "Addition of Stabilizing Layer to Increase Solid Oxide Fuel Cell Flatness Invention No. DP-308342" that Joseph M. Keller, Haskell Simpkins and I prepared on or before August 1, 2002 in the United States of America. *See Exhibit B*, 8 pages.

11. The presentation referred to in Paragraph 10 discloses a solid oxide fuel cell including a first electrode (i.e., anode and active anode) disposed on an electrolyte, and a stabilizing layer disposed on the first electrode on a side opposite of the electrolyte, wherein the electrolyte and the stabilizer layer are formed of the same material (i.e., yttra stabilized zirconia). *See Exhibit B*, pgs. 2-3.

12. The presentation referred to in Paragraph 10 states that that "[q]ualitative measurements have confirmed improved flatness for cells containing stabilizing layers . . . ." *See Exhibit B*, pg. 5.

13. On or before August 1, 2002, I and Joseph M. Keller conceived that the solid-oxide fuel cell described in Paragraphs 11 and 12 may be formed using the method recited in Paragraph 4.

14. The presentation referred to in Paragraph 10 further discloses that the solid oxide fuel cell described in Paragraphs 11 and 12 also includes a second electrode (i.e., cathode) is disposed on a side of the electrolyte opposite the first electrode. *See Exhibit B*, pg. 2.

15. On or before August 1, 2002, Joseph M. Keller and I conceived that the solid-oxide fuel cell described in Paragraph 14 may be formed using the method recited in Paragraph 5.

16. I actually reduced to practice the invention included in Paragraphs 4 and 5 set forth above on or before August 1, 2002.

17. On or before August 1, 2002, I formed a ceramic assembly by performing the steps of: disposing an anode precursor on an electrolyte precursor; disposing a stabilizer precursor on the electrode precursor on a side opposite the electrolyte precursor to form a precursor assembly, wherein the electrolyte and the stabilizer were both formed of yttria stabilized zirconia; and sintering the precursor assembly to form the ceramic assembly comprising a stabilizer layer, electrode, and electrolyte. *See U.S. Patent Application No. 10/797,301*, claim 1.

18. On or before August 1, 2002, I formed a solid oxide fuel cell by performing the steps of: disposing an anode precursor on a solid electrolyte precursor; disposing a stabilizer precursor on the anode precursor on a side opposite the electrolyte precursor to form a precursor assembly, wherein the electrolyte and the stabilizer were both formed of yttria stabilized zirconia; disposing an cathode precursor on a side of the solid electrolyte precursor opposite the anode precursor; and sintering the precursor assembly to form the ceramic assembly comprising a stabilizer layer, first electrode, and electrolyte. *See U.S. Patent Application No. 10/797,301*, claim 26.

19. The presentation referred to in Paragraph 10 includes a photograph of the ceramic assembly/solid oxide fuel cell that I formed by performing the steps recited in Paragraphs 17 and 18, wherein the photograph shows, among other features, a screen printed stabilizer layer formed of yttria stabilized zirconia attached to a fuel cell frame. *See Exhibit B*, pg. 8.

20. The presentation referred to in Paragraph 10 illustrates the results of a test that I performed on a ceramic assembly/solid oxide fuel cell that I formed by performing the steps recited in Paragraphs 17 and 18, wherein the stabilizer layer was formed using tape punching. *See Exhibit B*, pg. 7.

21. The test referred to in Paragraph 20 was conducted to determine the amount of camber on a surface of the ceramic assembly/solid oxide fuel cell formed by performing the steps recited in Paragraphs 17 and 18. *See Exhibit B*, pg. 7.

22. The results of the test referred to in Paragraph 20 were obtained using a UBM Non-Contact Imaging System. *See Exhibit B*, pg. 7.

23. The test referred to in Paragraph 20 shows that a surface of the ceramic assembly had less than or equal to about 5.0 degrees camber as measured from a horizontal plane. *See Exhibit B*, pg. 7.

24. As a result of the test referred to in Paragraph 20, Joseph M. Keller and I recognized that the method recited in Paragraphs 17 and 18 successfully resulted in the formation of a ceramic assembly/solid oxide fuel cell with increased flatness relative to a standard solid-oxide fuel cell that did not include a stabilizer layer. *See Exhibit B*, pgs. 3, 7.

25. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on the information and belief are believed to be true, and further that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001, and that such willful false statements may jeopardize the validity of the application or any patent issued thereof.

Dated: _____

_____
Robert J. Svoboda

[redacted] [redacted]

DELPHI
Automotive Systems

[redacted]

COPY

File Number: DP 308342

Product Code: _____

_____

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Record of Invention
and
Request for Intellectual Property Investigation

INNOVATION CENTER
FUEL CELL, SOFC

This Record of Invention provides written documentation of your invention and initiates a process that may result in the filing of a patent application.

Delphi Unit: INNOVATION CENTER - FLINT Site/Location: Technical Center Flint

Product group this invention applies to: Solid Oxide Fuel Cells

Invention Title: Addition of Stabilizing Layer to Increase Solid Oxide Fuel Cell Flatness

To disclose and record your invention, provide the following information:

1. *To the best of your present knowledge, describe the background of your invention. Briefly describe the prior apparatus, material or process that is improved, replaced or most similar to your invention. What are the problems or shortcoming of the prior apparatus, material or process that are overcome by your invention?*

   Flatness is an important aspect for the ceramic cell component of the solid oxide fuel cell system. Due to a shrinkage mismatch between the porous nickel and yttria stabilized zirconia anode and the dense yttria stabilized zirconia electrolyte the cell develops a camber during the sintering operation. Previously, the degree of camber was reduced slightly by a creep flattening process requiring the sintered cells to be fired at high temperature under ceramic weights. Creep flattening is time consuming and adds large amounts of energy due to the additional firing step required. Also, it only reduces camber by a limited amount.

2. *Describe your invention. Provide enough detail of the specific new features, components or steps that form the invention to enable a technical understanding of its content and novelty. Include a drawing with reference numbers keyed to your text description. Explain how your invention differs from and improves or solves the problems of the prior apparatus, material or process described above.*

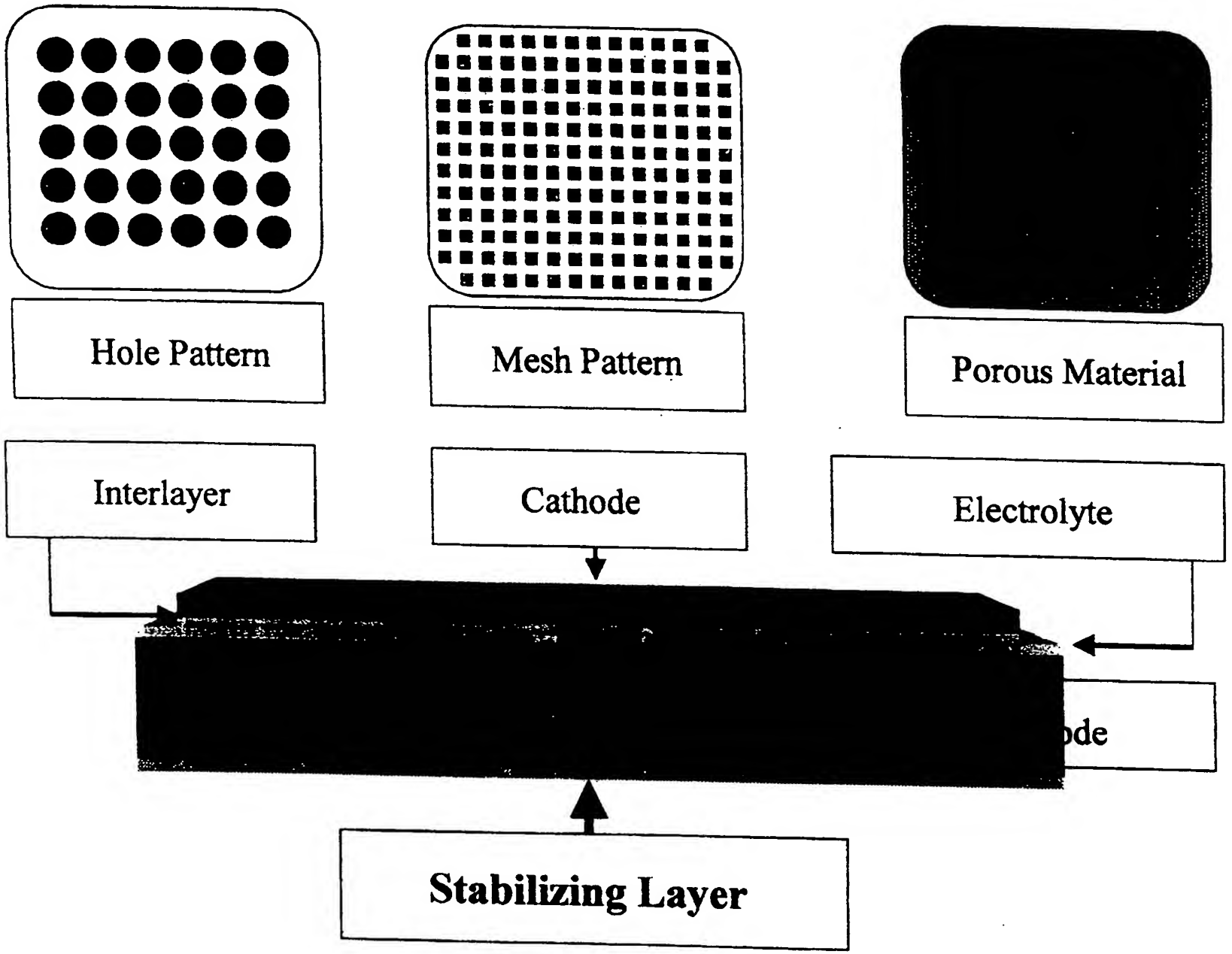
The invention uses yttria stabilized zirconia or a material of similar shrinkage properties as a stabilizing layer on the anode side of the electrolyte-anode composite bi-layer. The similar shrinkage properties on each side of the anode will counter-balance the distortion caused by the shrinkage mismatch of the electrolyte and the anode.

Besides thermal expansion matching with the electrolyte, the stabilizing layer must account for these other critical properties:
1.) Sufficient transfer of fuel gas into the anode
2.) Electrical contact with the anode

Four solution are proposed:
1.) An elastomer based yttria stabilized zirconia tape is applied to the anode side of the electrolyte-anode composite bi-layer. The tape is manufactured with an open hole or mesh pattern.
2.) A solvent-based yttria stabilized zirconia slurry is applied in an open hole or mesh pattern to the anode side of the electrolyte-anode composite bi-layer. The slurry can be applied using screenprinting, spraying, or other methods.
3.) An elastomer yttria stabilized zirconia tape containing fugitive material is applied to the anode side of the electrolyte-anode composite bi-layer. The fugitive material will burn off at temperatures below the sintering temperature causing voids in the fired ceramic.
4.) A solvent-based yttria stabilized zirconia slurry containing fugitive material is applied to the anode side of the electrolyte-anode composite bi-layer. The fugitive material will burn off at temperatures below the sintering temperature causing voids in the fired ceramic.

Key features of the open pattern design (1 and 2):
1.) The patterns must contain enough open area to allow sufficient gas flow to the anode
2.) Electrical contact must be made at the open areas

Key features of the fugitive material design (3 and 4):
1.) Porosity must be great enough to allow sufficient gas flow to the anode
2.) A conductive material (such as nickel) must be applied after firing. A solvent-based nickel slurry can be applied, diffusing into the pore structure making electrical contact to the anode layer. The nickel can be printed in an open pattern to allow for gas flow into the anode.


Hole Pattern
Mesh Pattern
Porous Material
Interlayer
Cathode
Electrolyte
Stabilizing Layer

To help establish the date and status of your invention, provide the following information:

3. *Date this invention was first thought of:* [redacted]

4. *Attach a copy of the first written description and/or sketch of the invention. (preferably signed, dated & witnessed).*

5. *Date this invention was or is expected to be disclosed outside of Delphi:* no
   If disclosed, to whom: (customer, supplier, public, etc.) _____

6. *Date this invention was used or is committed to be used in production:* _____

7. *Date this invention or a system including or using this invention was or will be offered for sale outside Delphi:* _____

8. *Does this invention relate to a Government Contract?* Yes ☐ No ☐
   If yes, identify the government Contract/Purchase Order No. _____

If a patent application is to be filed on your invention, you may be contacted to provide (1) further information about your knowledge of prior art or events that might affect our ability to obtain a patent and (2) a more complete or updated description of what you consider to be the best mode of carrying out your invention.

Inventor #1

Name: Robert (First Name) J (Middle Initial) Svoboda (Last Name) Citizen of: USA

Social Security No. [redacted] Delphi Employee: ☐ Yes ⇐ ☐ Salary ☐ Hourly

☐ No ⇐ ☒ Contract ☐ Other

Home Address: 6128 King Arthur Dr (Street / P.O. Box No.) Swartz Creek, MI (City and State) 48473 (Zip Code) Home Telephone: [redacted] (Area Code) + Number

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Immediate Manager: Joseph Keller Mail Code: 485-220-130 Telephone: [redacted] (Area Code) + Number

2nd Level Manager: Rick Kerr Mail Code: 485-220-130 Telephone: [redacted] (Area Code) + Number

Contract Employer: Rapid Design Systems Telephone: [redacted] (Area Code) + Number

(if applicable)
Contract Employer Address: 3089 Tri-Park Dr (Street) Grand Blanc (City and State) MI 48439-0237 (Zip Code)

Inventor #2

Name: Haskell (First Name) _____ (Middle Initial) Simpkins (Last Name) Citizen of: US

Social Security No. [redacted] Delphi Employee: ☒ Yes ⇐ ☒ Salary ☐ Hourly

☐ No ⇐ ☐ Contract ☐ Other

Home Address: 12214 WELLINGTON DR (Street / P.O. Box No.) (City and State) (Zip Code) Home Telephone: [redacted] (Area Code) + Number

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Department Name/Number: 15652 Mail Code: 146-HGW-57B

Immediate Manager: STEVE SHAFFER Mail Code: 146-HGW-57B Telephone: [redacted] (Area Code) + Number

2nd Level Manager: JIM ZIEGLMAN Mail Code: 146HGW575 Telephone: [redacted] (Area Code) + Number

Contract Employer: (If applicable) Telephone: (Area Code) + Number

Contract Employer Address: (Street) (City and State) (Zip Code)

Inventor #3

Name: Joseph (First Name) M (Middle Initial) Keller (Last Name) Citizen of: US.

Social Security No. [redacted] Delphi Employee: ☒ Yes ⇐ ☒ Salary ☐ Hourly

☐ No ⇐ ☐ Contract ☐ Other

Home Address: 1087 RANSOM Dr. FLINT, MI 48507 (Street / P.O. Box No.) (City and State) (Zip Code) Home Telephone: [redacted] (Area Code) + Number

Work Address: 1601 N. ANDRILL AVE. FLINT 48556 Telephone: [redacted] (Area Code) + Number Fax Number: [redacted] (Area Code) + Number

Department Name/Number: 32-22 Mail Code: 485-220-130

Immediate Manager: RICK KERR Mail Code: 485-220-130 Telephone: [redacted] (Area Code) + Number

2nd Level Manager: RUSS BOSCH Mail Code: 485-220-130 Telephone: [redacted] (Area Code) + Number

Contract Employer: (If applicable) Telephone: (Area Code) + Number

Contract Employer Address: (Street) (City and State) (Zip Code)

** If there are more than three (3) inventors, copy this page as needed. **

Guidelines for Description of Invention

Mechanical and Electrical Devices: Include a detailed description and drawings which illustrate all essential elements of the invention and the environment in which it is used. The description should describe the structure and its operation key-numbered to the drawing(s). To the extent known, alternate embodiments should be described. In the case of systems and circuits, use accepted symbols or labeled blocks for standard components. A computer program or controlling algorithm, if important to the invention, should be provided in flow chart or similarly accepted format, and input/output signals should be identified and related to appropriate sensors/actuators.

Chemical and Material Inventions: Identify all essential materials (in chemical terms, not trade names) used and alternatives therefor. All significant variables needed to define the invention must be identified, quantified and discussed. Depending on the nature of the invention, such variables might include treatment/reaction times, temperature, pressure, concentration, particle shape/size, viscosity, crystal structure, phases, porosity, pH, density, tensile strength, polymer chain length, etc. Each variable should be quantified in terms of an operative range and a preferred embodiment, e.g. "The heat treatment is carried out between 100°C and 200°C (preferably 165°C)". The function/purpose of each variable should be described, including a statement as to what happens if the variable falls outside the operative range, e.g. "Component A serves as a plasticizer for Component B. Below 100°C, Component A will not mix with Component B, and above 200°C it evaporates." Finally, a recipe for at least one detailed working example should be provided. Preferably, several such examples will be provided covering the full range of the significant variables used to define the invention.

Processes: Include a schematic of the components monitored, controlled and/or created by the process and a flow chart of the process illustrating the steps of the process at a level from which one skilled in the art can understand and implement the process. The description should set forth the operation of the process describing each step of the flow chart and its relationship or interaction with the components monitored, controlled and/or created by the process.

Protecting Your Invention

When a new idea comes to you, immediately make a drawing or sketch of it and write a brief description sufficient to make your invention clear to others working in the same field. Show the drawing and description to two of your associates who are not co-inventors and make sure they understand your invention. You and your co-inventors, and your associates as witnesses, should sign and date the drawing and description. The date used must be the date of the signature. The witnesses should state above their signatures that the drawing and description were reviewed and understood by them. Include the documents with your Record of Invention.

Be aware that patent rights may be lost irrevocably by action of law, in spite of timely documentation and submission of a Record of Invention, through actions taken by you or others prior to an actual patent application being filed in the appropriate government Patent Office. Such actions may include: (a) publishing the invention, (b) using the invention in public or commercially in our plants, (c) disclosing or offering to sell an item incorporating the invention outside Delphi or (d) obtaining a quote for such an item from a supplier. Please submit your Record of Invention without delay when you think of an invention and report any past or planned disclosure of the invention outside Delphi or commercial use of the invention so appropriate steps may be taken to avoid loss of patent rights.

Authorization

I hereby assign this invention to Delphi Technologies, Inc. and authorize Delphi Technologies, Inc. to file a patent application on my behalf.

INVENTOR – SIGNATURE	Robert J. Svoboda (ALSO, PRINT NAME)	[redacted] DATE
INVENTOR – SIGNATURE	HASKELL SIMPKINS (ALSO, PRINT NAME)	[redacted] DATE
INVENTOR – SIGNATURE	JOSEPH M. KELLER (ALSO, PRINT NAME)	[redacted] DATE

Inventor verifies this date.
Jack Tubbs, [redacted]

This invention was reviewed and understood by the witnesses below:

1st WITNESS – SIGNATURE	David P. Wallace II (ALSO, PRINT NAME)	[redacted] DATE
2nd WITNESS – SIGNATURE	CHARLES D OAKLEY (ALSO, PRINT NAME)	[redacted] DATE

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Addition of Stabilizing Layer to Increase Solid Oxide Fuel Cell Flatness

Invention No. DP-308342

Robert Svoboda
Haskell Simpkins
Joe Keller

08/01/02

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Solid Oxide Fuel Cell

Platinum Grid
1 Screen Print Layer

Cathode: (60 μm)
3 Screen Print Layers

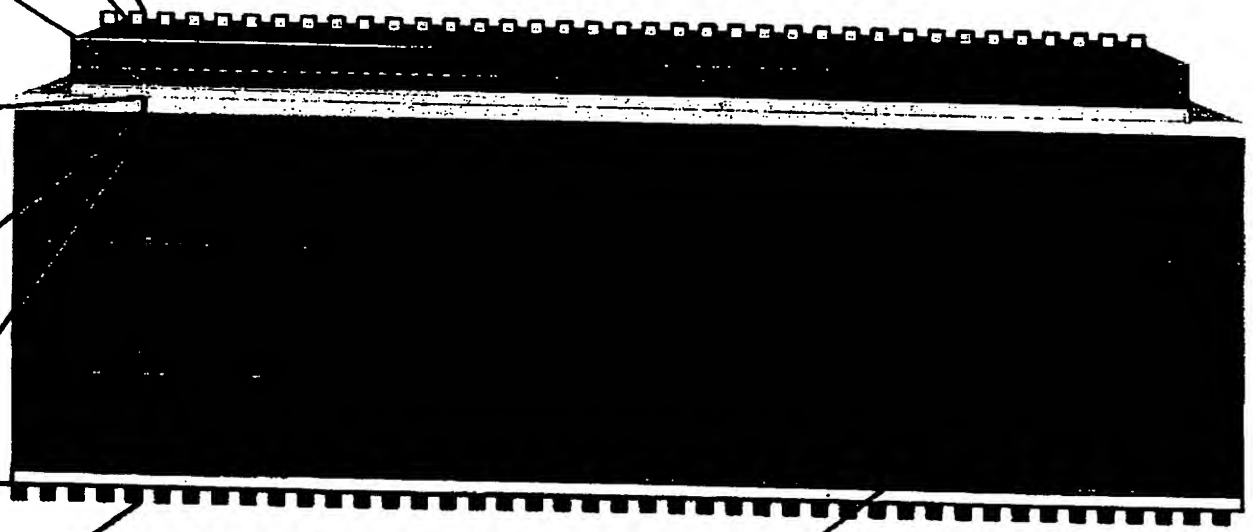
Interlayer: (20 μm)
1 Screen Print Layer

Electrolyte: (20 μm)
1 Tape Cast Layer

Active Anode: (20 μm)
1 Tape Cast Layer

Anode: (600 μm)
3 Tape Cast Layers

Nickel Oxide Grid
1 Screen Print Layer



New Stabilizing Layer Added

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Scope and Significance

- Yttria stabilized zirconia placed on both sides of cells
- Design Criteria for "stabilizing" zirconia layer
  - Electrical impedance must not be significantly increased
  - Gas flow through the anode must not be significantly decreased
- Improvements in cell quality
  - Increased mechanical strength and durability
  - Reduced cell warping
  - Enhanced sealing

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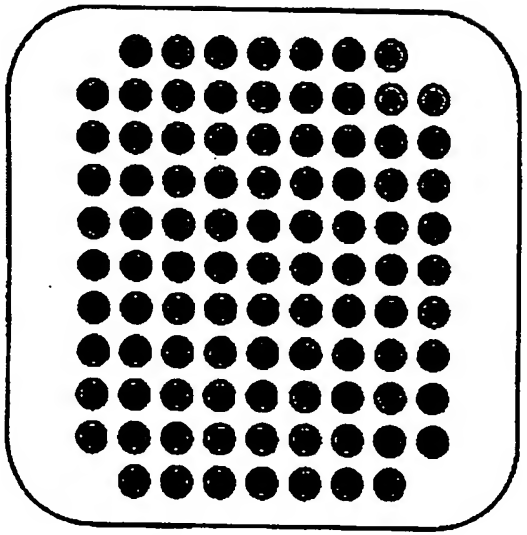
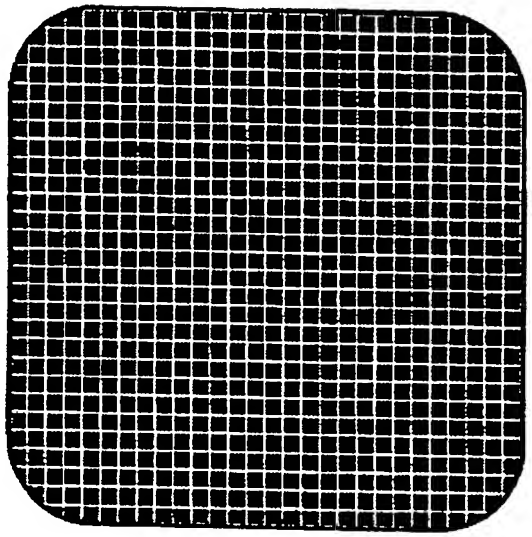
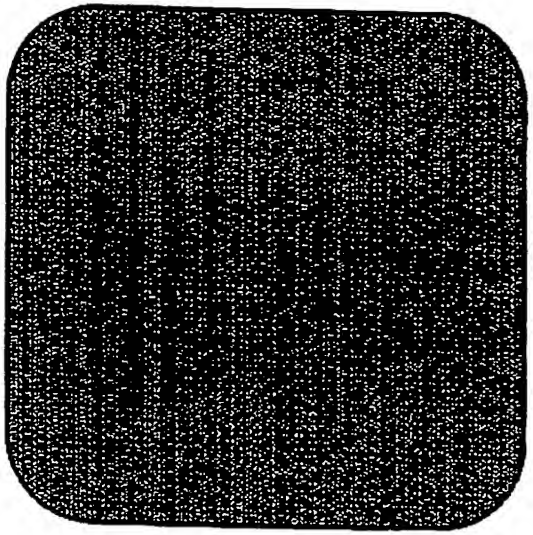
Stabilizing Layer Designs



Hole Punched Tape



Screen Print



Porous YSZ Layer

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Current State

- Cells have been manufactured using tape punching, screen printing, and porous tape methods methods
- Quantitative measurements have confirmed improved flatness for cells containing stabilizing layers that were fabricated using tape punching and screen printing methods
- Cell with screen printed stabilizing layer successfully sealed to frame.

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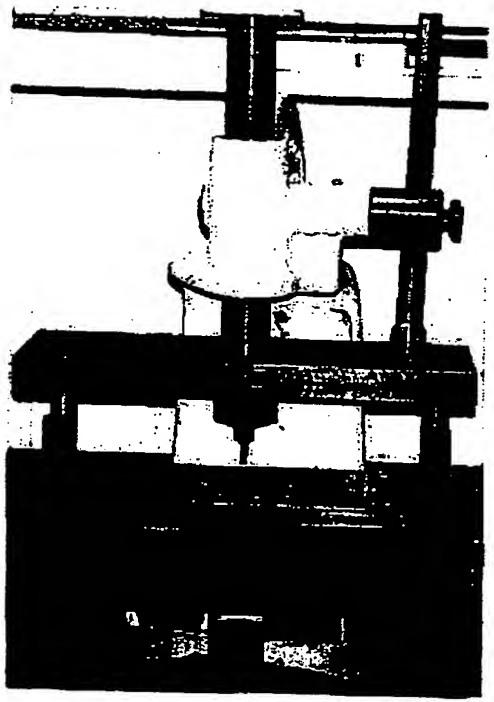
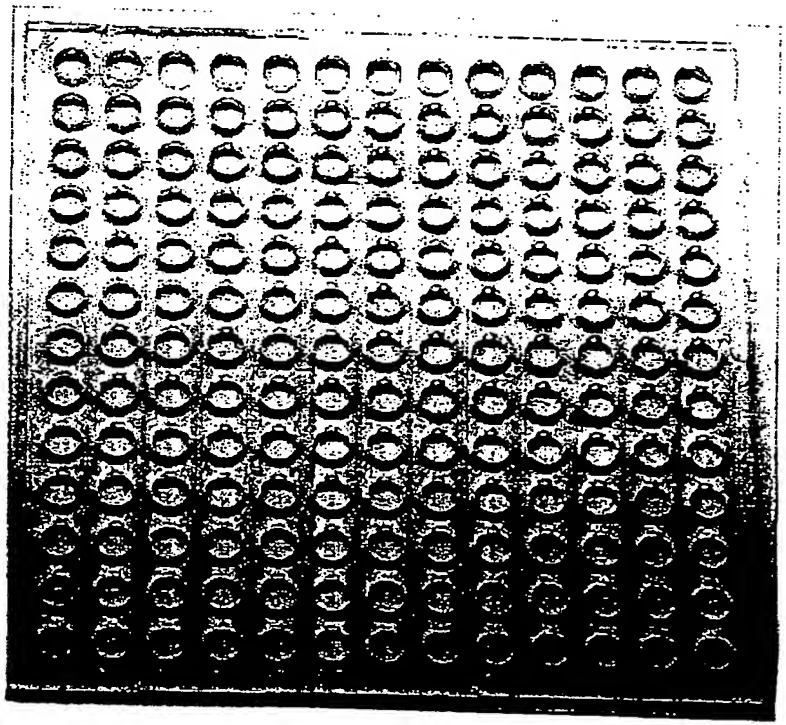
Tape Punching System

Hole Press



Hole Fixture



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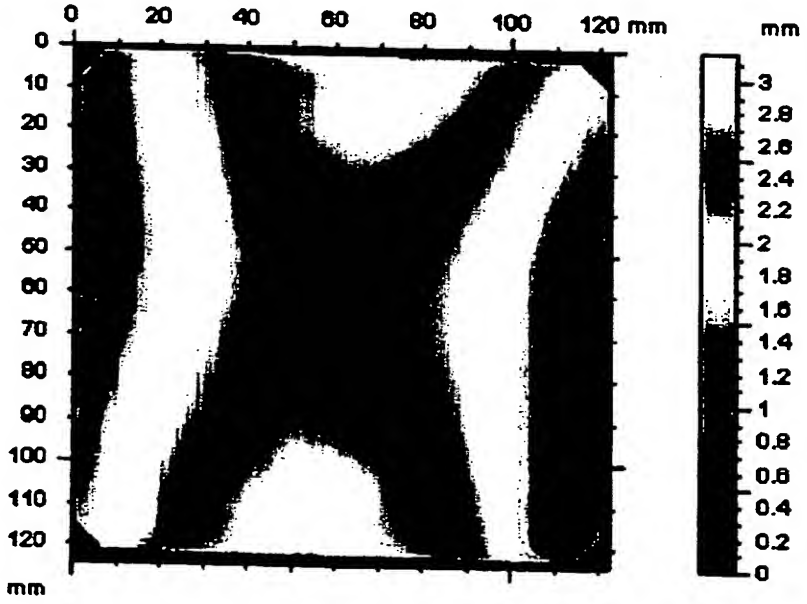
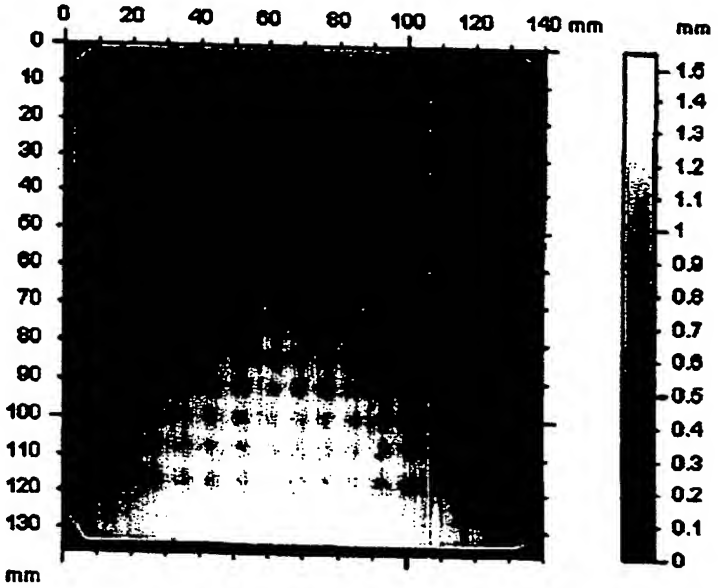
Tape Punched Cell Flatness Measurement Comparison

Solid oxide fuel cell camber of standard cell and a cell containing a punched tape - cast stabilizing layer as measured on a UBM Noncontact Imaging System.

Standard Cell



Cell with stabilizing layer



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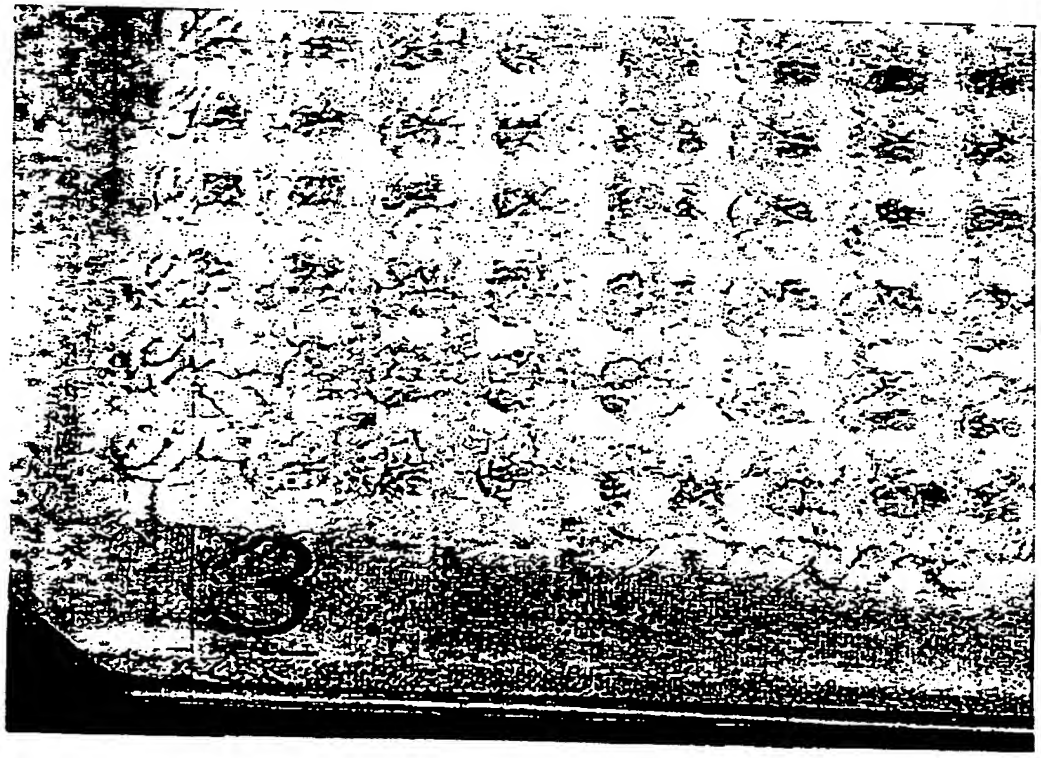
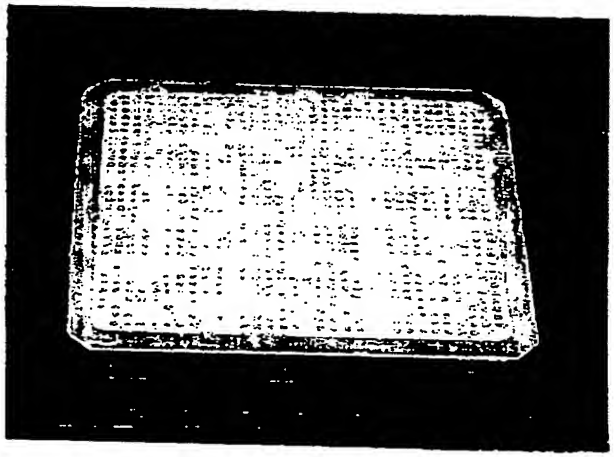
Screen Printed Cell Sealed Into Frame

Yttria stabilized zirconia screen printed grid underneath nickel grid (below)





Yttria stabilized zirconia screen printed cell attached to frame (above)

Exhibit C

7008 0150 0000 7682 3553

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Street, Apt. No.; or PO Box No.: 6128 King Arthur Dr.
City, State, ZIP+4: Swartz Creek, MI 48473

PS Form 3800, August 2006 — See Reverse for Instructions

Exhibit D

SENDER: *COMPLETE THIS SECTION*

- Complete items 1, 2, and 3. Also complete item 4 if Restricted Delivery is desired.
- Print your name and address on the reverse so that we can return the card to you.
- Attach this card to the back of the mailpiece, or on the front if space permits.

1. Article Addressed to:

Robert J. Svoboda
6128 King Arthur Dr.
Swartz Creek, MI
48473

COMPLETE THIS SECTION ON DELIVERY

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X Mark Svoboda ☐ Agent ☐ Addressee

B. Received by *(Printed Name)*
MARK SVOBODA

C. Date of Delivery

D. Is delivery address different from item 1? ☐ Yes
If YES, enter delivery address below: ☐ No

3. Service Type
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☐ Registered ☑ Return Receipt for Merchandise
☐ Insured Mail ☐ C.O.D.

4. Restricted Delivery? *(Extra Fee)* ☐ Yes

2. Article Number
(Transfer from service label) 7008 0150 0000 7682 3553

PS Form 3811, February 2004 Domestic Return Receipt 102595-02-M-1540

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Dennis B. Danella, Esq.
Woods Oviatt Gilman LLP
700 Crossroads Bldg.
2 State Street
Rochester, NY 14614

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